§ 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 19-0036.

Amendments

In the Specification:

Please replace the paragraph beginning on page 1, line 7 with the following paragraph:

This application is a continuation-in-part of Appl. No. 09/016,361, filed January 30, 1998, which is incorporated herein by reference; and is a continuation-in-part of Appl. No. 09/098,584, filed June 17, 1998; and is a continuation-in-part of Appl. No. 09/017,735, filed February 3, 1998; and is a continuation-in-part of Appl. No. 08/589,108, filed January 23, 1996; and is a continuation-in-part of Appl. No. 08/205,713, filed March 4, 1994; and is a continuation-in-part of 08/821,739, filed March 20, 1997; and claims the benefit of U.S. Provisional Appl. No. 60/141,422, filed June 29, 1999; and claims the benefit of U.S. Provisional Appl. No. 60/170,448, filed December 13, 1999; said 08/205,713 is a continuation-in-part of 08/159,184, filed November 29, 1993, abandoned; which is a continuation-in-part of Appl. No. 08/073,205, filed June 4, 1993 , abandoned; which is a continuation-in-part of Appl. No. 08/027,146, filed March 5, 1993, abandoned; said 08/821,739 claims the benefit of U.S. Provisional Appl. No. 60/013,833, filed March 21, 1996; and said 08/821,739 is a continuation-in-part of U.S. Appl. No. 08/589,107, filed July 12, 1996, abandoned; and is a continuation-in-part of U.S. Appl. No. 08/451,913, filed May

26, 1995, abandoned; and is a continuation-in-part of U.S. Appl. No. 08/347,610, filed December 1, 1994; and is a continuation-in-part of U.S. Appl. No. 08/186,266, filed January 25, 1994, U.S. Patent No. 5,662,907; and is a continuation-in-part of U.S. Appl. No. 08/159,339, filed November 29, 1993, U.S. Patent No. 6,037,135; which is a continuation-in-part of U.S. Appl. No. 08/103,396, filed August 6, 1993, abandoned; which is a continuation-in-part of U.S. Appl. No. 08/027,746, filed March 5, 1993, abandoned; said 09/016,361 claims the benefit of U.S. Provisional Appl. No. 60/036,696, filed January 31, 1997, which is incorporated herein by reference.

Please replace the paragraph beginning on page 2, line 1 with the following paragraph:

3. HLA Class II Motifs and PADRE®

Please replace the paragraph beginning on page 6, line 20 with the following paragraph:

Figure 1 depicts that PADRE® promotes antigen specific T cell responses from human PBMC. In Figure 1, PBMC from three healthy donors (donors 431, 397, and 344) were stimulated *in vitro*. In brief, Ficoll-Paque (Pharmacia LKB) purified PBMC were plated at 4 x 10^6 cells/well in a 24-well tissue culture plate (Costar). The peptides were added at a final concentration of 10 μg/ml and incubated at 37°C for 4 days. Recombinant interleukin-2 was added at a final concentration of 10 ng/ml and the cultures were fed every three days with fresh media and cytokine. Two additional stimulations of the T cells with antigen were performed on approximately days 14 and 28. The T cells (3 x 10^5 cells/well)

were restimulated with 10 μg/ml peptide using irradiated (7500 rads) autologous PBMC cells. T cell proliferative responses were determined using a ^{3}H-thymidine incorporation assay.

Please replace the paragraph beginning on page 7, line 1 with the following paragraph:

Figure 2 depicts that PADRE®-specific proliferative responses are induced via peptide vaccination. In Figure 2, two weeks after vaccination, PBMC of 4 out of 12 cervical cancer patients (002, 005, 008, and 014) displayed proliferation when stimulated *in vitro* with 5 μg/ml PADRE® peptide (4/12= 33% responding patients, 95% interval 10-65%) (Tx = treatment). The proliferation index of multiple wells was calculated as the mean cpm from experimental wells divided by the mean cpm from control wells. PADRE®-specific responses were considered positive when the proliferation index exceeded 5. The variation between replicates was always less than 25% (Ressing *et al., Detection of immune responses to helper peptide, but not to viral CTL epitopes, following peptide vaccination of immunocompromised patients with recurrent cervical carcinoma.* Submitted (1999)).

Please replace the paragraph beginning on page 13, line 1 with the following paragraph:

The phrases "isolated" or "biologically pure" refer to material which is substantially or essentially free from components which normally accompany the material as it is found in its native state. Thus, isolated peptides in accordance with the invention preferably do not contain materials normally associated with the peptides in their *in situ* environment. An

"isolated" epitope refers to an epitope that does dot include the whole sequence of the antigen or polypeptide from which the epitope was derived. Typically the "isolated" epitope does not have attached thereto additional amino acids that result in a sequence that has 100% identity with a native sequence. The native sequence can be a sequence such as a tumor-associated antigen from which the epitope is derived.

Please replace the paragraph beginning on page 13, line 30 with the following paragraph:

A "PanDR binding peptide" or "PADRE®" molecule (Epimmune, San Diego, CA) is a member of a family of molecules that binds more than one HLA class II DR molecule. The pattern that defines the PADRE® family of molecules can be referred to as an HLA Class II supermotif. A PADRE® molecule binds to HLA-DR molecules and stimulates *in vitro* and *in vivo* human helper T lymphocyte (HTL) responses. For a further definition of the PADRE® family, see copending application USSN 09/310,462, now abandoned in favor of USSN 09/709,774, filed November 8, 2000; PCT publication WO 95/07707, and, U.S. Patent 5,736,142 issued April 7, 1998.

Please replace the paragraph beginning on page 26, line 32 with the following paragraph:

Vaccines of the present invention may also comprise epitopes that bind to MHC class II DR molecules. A greater degree of heterogeneity in both size and binding frame position of the motif, relative to the N and C termini of the peptide, exists for class II peptide ligands. This increased heterogeneity of HLA class II peptide ligands is due to the structure of the

binding groove of the HLA class II molecule which, unlike its class I counterpart, is less physically constricted at both ends. Crystallographic analysis of HLA class II DRB*0101-peptide complexes to identify the residues associated with major binding energy identified those residues complexed with complementary pockets on the DRBI*0101 molecules. An important anchor residue engages the deepest hydrophobic pocket (*see, e.g.*, Madden, D.R. *Ann. Rev. Immunol.* 13:587 (1995)) and is referred to as position 1 (P1). P1 may represent the N-terminal residue of a class II binding peptide epitope, but more typically is flanked towards the N-terminus by one or more residues. Other studies have also pointed to an important role for the peptide residue in the sixth position towards the C-terminus, relative to P1, for binding to various DR molecules. See, *e.g.*, U.S. Patent 5,736,142, and a co-pending application entitled Alteration Of Immune Responses Using Pan DR Binding Peptides, U.S.S.N. 09/310,462, now abandoned in favor of U.S.S.N 09/709,774, filed November 8, 2000.

Please replace the paragraph beginning on page 41, line 32 with the following paragraph:

In certain embodiments, components that induce T cell responses are combined with components that induce antibody responses to the target antigen of interest. A preferred embodiment of such a composition comprises class I and class II epitopes in accordance with the invention. Alternatively, a composition comprises a class I and/or class II epitope in accordance with the invention, along with a PADRE® molecule (Epimmune, San Diego, CA).

Please replace the paragraph beginning on page 44, line 6 with the following paragraph:

The use of multi-epitope minigenes is also described in, *e.g.*, co-pending application U.S.S.N. 09/311,784; Ishioka *et al.*, *J. Immunol.* 162:3915-3925, 1999; An, L. and Whitton, J. L., *J. Virol.* 71:2292, 1997; Thomson, S. A. *et al.*, *J. Immunol.* 157:822, 1996; Whitton, J. L. *et al.*, *J. Virol.* 67:348, 1993; Hanke, R. *et al.*, *Vaccine* 16:426, 1998. For example, a multi-epitope DNA plasmid encoding nine dominant HLA-A*0201- and A11-restricted CTL epitopes derived from the polymerase, envelope, and core proteins of HBV and human immunodeficiency virus (HIV), a PADRE® universal helper T cell (HTL) epitope, and an endoplasmic reticulum-translocating signal sequence has been engineered. Immunization of HLA transgenic mice with this plasmid construct resulted in strong CTL induction responses against the nine CTL epitopes tested. This CTL response was similar to that observed with a lipopeptide of known immunogenicity in humans, and significantly greater than immunization using peptides in oil-based adjuvants. Moreover, the immunogenicity of DNA-encoded epitopes *in vitro* was also correlated with the *in vitro* responses of specific CTL lines against target cells transfected with the DNA plasmid. These data show that the minigene served: 1.) to generate a CTL response and 2.) to generate CTLs that recognized cells expressing the encoded epitopes. A similar approach can be used to develop minigenes encoding TAA epitopes.

Please replace the paragraph beginning on page 45, line 31 with the following paragraph:

In some embodiments, a bi-cistronic expression vector which allows production of both the minigene-encoded epitopes and a second protein (*e.g.*, one that modulates immunogenicity) can be used. Examples of proteins or polypeptides that, if co-expressed with epitopes, can enhance an immune response include cytokines (*e.g.*, IL-2, IL-12, GM-CSF), cytokine-inducing molecules (*e.g.*, LeIF), costimulatory molecules, or pan-DR binding proteins (PADRE®, Epimmune, San Diego, CA). Helper T cell (HTL) epitopes such as PADRE® molecules can be joined to intracellular targeting signals and expressed separately from expressed CTL epitopes. This can be done in order to direct HTL epitopes to a cell compartment different than that of the CTL epitopes, one that provides for more efficient entry of HTL epitopes into the HLA class II pathway, thereby improving HTL induction. In contrast to HTL or CTL induction, specifically decreasing the immune response by co-expression of immunosuppressive molecules (*e.g.* TGF-β) may be beneficial in certain diseases.

C10

Please replace the paragraph beginning on page 47, line 30 with the following paragraph:

For instance, the ability of a peptide to induce CTL activity can be enhanced by linking the CTL peptide to a sequence which contains at least one HTL epitope. The use of T helper epitopes in conjunction with CTL epitopes to enhance immunogenicity is illustrated, for example, in co-pending applications U.S.S.N. 08/820,360, abandoned,

C11

C1 Cont'd U.S.S.N. 08/197,484, now U.S. Patent No. 6,419,931, and U.S.S.N. 08/464,234, abandoned in favor of U.S.S.N. 08/197,484, now U.S. Patent No. 6,419,931.

Please replace the paragraph beginning on page 48, line 23 with the following paragraph:

Alternatively, it is possible to prepare synthetic peptides capable of stimulating T helper lymphocytes, in a loosely HLA-restricted fashion, using amino acid sequences that may not be found in nature. Synthetic compounds fall within the family of molecules called Pan-DR-binding epitopes (*e.g.*, PADRE®, Epimmune Inc., San Diego, CA). PADRE® peptides are designed to bind multiple HLA-DR (human HLA class II) molecules. For instance, a pan-DR-binding epitope peptide having the formula: aKXVAAZTLKAAa, where "X" is either cyclohexylalanine, phenylalanine, or tyrosine; "Z" is either tryptophan, tyrosine, histidine or asparagine; and "a" is either D-alanine or L-alanine (SEQ ID NO:29), has been found to bind to numerous allele-specific HLA-DR molecules. Accordingly, these molecules stimulate a T helper lymphocyte response from most individuals, regardless of their HLA type. Certain pan-DR binding epitopes comprise all "L" natural amino acids; these molecules can be provided as peptides or in the form of nucleic acids that encode the peptide.

C1 2

Please replace the paragraph beginning on page 50, line 12 with the following paragraph:

The DC can be pulsed *ex vivo* with a cocktail of peptides, some of which stimulate CTL responses to one or more antigens of interest, *e.g.*, tumor associated antigens (TAA)

C1 3

such as HER2/neu, p53, MAGE 2, MAGE3, and/or carcinoembryonic antigen (CEA). Collectively, these TAA are associated with breast, colon and lung cancers. Optionally, a helper T cell (HTL) peptide such as PADRE®, can be included to facilitate the CTL response. Thus, a vaccine in accordance with the invention comprising epitopes from HER2/neu, p53, MAGE 2, MAGE3, and carcinoembryonic antigen (CEA) is used to treat minimal or residual disease in patients with malignancies such as breast, colon or lung cancer; any malignancies that bear any of these TAAs can also be treated with the vaccine. A TAA vaccine can be used following debulking procedures such as surgery, radiation therapy or chemotherapy, whereupon the vaccine provides the benefit of increasing disease free survival and overall survival in the recipients.

C13 cont'd

Please replace the paragraph beginning on page 61, line 15 with the following paragraph:

C14

A PADRE® Molecule as a Helper Epitope for Enhancement of CTL Induction

Please replace the paragraph beginning on page 61, line 17 with the following paragraph:

There is increasing evidence that HTL activity is critical for the induction of long lasting CTL responses (Livingston *et al. J. Immunol* 162:3088-3095 (1999); Walter *et al., New Engl. J. Med.* 333:1038-1044 (1995); Hu *et al., J. Exp. Med.* 177:1681-1690 (1993)). Therefore, one or more peptides that bind to HLA class II molecules and stimulate HTLs can be used in accordance with the invention. Accordingly, a preferred embodiment of a vaccine includes a molecule from the PADRE® family of universal T helper cell epitopes (HTL) that

C15

target most DR molecules in a manner designed to stimulate helper T cells. For instance, a pan-DR-binding epitope peptide having the formula: aKXVAAZTLKAAa, where "X" is either cyclohexylalanine, phenylalanine, or tyrosine; "Z" is either tryptophan, tyrosine, histidine or asparagine; and "a" is either D-alanine or L-alanine (SEQ ID NO:29), has been found to bind to most HLA-DR alleles, and to stimulate the response of T helper lymphocytes from most individuals, regardless of their HLA type.

C15

Please replace the paragraph beginning on page 61, line 30 with the following paragraph:

A particularly preferred PADRE® molecule is a synthetic peptide, aKXVAAWTLKAAa(a = D-alanine, X = cyclohexylalanine), containing non-natural amino acids, specifically engineered to maximize both HLA-DR binding capacity and induction of T cell immune responses.

C16

Please replace the paragraph beginning on page 62, line 1 with the following paragraph:

Alternative preferred PADRE® molecules are the peptides, aKFVAAWTLKAAa, aKYVAAWTLKAAa, aKFVAAYTLKAAa, aKXVAAYTLKAAa, aKYVAAYTLKAAa, aKFVAAHTLKAAa, aKXVAAHTLKAAa, aKYVAAHTLKAAa, aKFVAANTLKAAa, aKXVAANTLKAAa, aKYVAANTLKAAa, AKXVAAWTLKAAA (SEQ ID NO:30), AKFVAAWTLKAAA (SEQ ID NO:31), AKYVAAWTLKAAA (SEQ ID NO:32), AKFVAAYTLKAAA (SEQ ID NO:33), AKXVAAYTLKAAA (SEQ ID NO:34), AKYVAAYTLKAAA (SEQ ID NO:35), AKFVAAHTLKAAA (SEQ ID NO:36),

C17

AKXVAAHTLKAAA (SEQ ID NO:37), AKYVAAHTLKAAA (SEQ ID NO:38), AKFVAANTLKAAA (SEQ ID NO:39), AKXVAANTLKAAA (SEQ ID NO:40), AKYVAANTLKAAA (SEQ ID NO:41) (a = D-alanine, X = cyclohexylalanine).

Please replace the paragraph beginning on page 62, line 11 with the following paragraph:

In a presently preferred embodiment, the PADRE® peptide is amidated. For example, a particularly preferred amidated embodiment of a PADRE® molecule is conventionally written aKXVAAWTLKAAa-NH_2.

Please replace the paragraph beginning on page 62, line 14 with the following paragraph:

Competitive inhibition assays with purified HLA-DR molecules demonstrated that the PADRE® molecule aKXVAAWTLKAAa-NH_2 binds with high or intermediate affinity (IC_{50} ≤1,000 nM) to 15 out of 16 of the most prevalent HLA-DR molecules ((Kawashima *et al., Human Immunology* 59:1-14 (1998); Alexander *et al., Immunity* 1:751-761 (1994)). A comparison of the DR binding capacity of PADRE® and tetanus toxoid (TT) peptide 830-843, a "universal" epitope has been published (Panina-Bordignon *et al., Eur. J. Immunology* 19:2237-2242 (1989)). The TT 830-843 peptide bound to only seven of 16 DR molecules tested, while PADRE® bound 15 of 16. At least 1 of the 15 DR molecules that bind PADRE® is predicted to be present in >95% of all humans. Therefore, this PADRE® molecule is anticipated to induce an HTL response in virtually all patients, despite the extensive polymorphism of HLA-DR molecules in the human population.

Please replace the paragraph beginning on page 62, line 26 with the following paragraph:

PADRE® has been specifically engineered for optimal immunogenicity for human T cells. Representative data from *in vitro* primary immunizations of normal human T cells with TT 830-843 antigen and the PADRE® molecule aKXVAAWTLKAAa-NH_2 are shown in Figure 1. Peripheral blood mononuclear cells (PBMC) from three normal donors were stimulated with the peptides *in vitro*. Following the third round of stimulation, it was observed that PADRE® generated significant primary T cell responses for all three donors as measured in a standard T cell proliferation assay. With the PADRE® peptide, the 10,000 cpm proliferation level was generally reached with 10 to 100 ng/ml of antigen. In contrast, TT 830-843 antigen generated responses for only 2 out of 3 of the individuals tested. Responses approaching the 10,000 cpm range were reached with about 10,000 ng/ml of antigen. In this respect, it was noted that PADRE® was, on a molar basis, about 100-fold more potent than TT 830-843 antigen for activation of T cell responses.

Please replace the paragraph beginning on page 63, line 5 with the following paragraph:

Early data from a phase I/II investigator-sponsored trial, conducted at the University of Leiden (C.J.M. Melief), support the principle that the PADRE® molecule aKXVAAWTLKAAa, possibly the amidated aKXVAAWTLKAAa -NH_2, is highly immunogenic in humans (Ressing *et al., Detection of immune responses to helper peptide, but not to viral CTL epitopes, following peptide vaccination of immunocompromised patients with recurrent cervical carcinoma.* Submitted (1999)). In this trial, a PADRE®

molecule was co-emulsified with various human papilloma virus (HPV)-derived CTL epitopes and was injected into patients with recurrent or residual cervical carcinoma. However, because of the late stage of carcinoma with the study patients, it was expected that these patients were immunocompromised. The patients' immunocompromised status was demonstrated by their low frequency of influenza virus-specific CTL, reduced levels of CD3 expression, and low incidence of proliferative recall responses after *in vitro* stimulation with conventional antigens. Thus, no efficacy was anticipated in the University of Leiden trial, rather the goal of that trial was essentially to evaluate safety. Safety was, in fact, demonstrated. In addition to a favorable safety profile, PADRE® T cell reactivity was detected in four of 12 patients (Figure 2) in spite of the reduced immune competence of these patients.

Please replace the paragraph beginning on page 63, line 22 with the following paragraph:

Thus, the PADRE® peptide component(s) of the vaccine bind with broad specificity to multiple allelic forms of HLA-DR molecules. Moreover, PADRE® peptide component(s) bind with high affinity (IC_{50} £1000 nM), i.e., at a level of affinity correlated with being immunogenic for HLA Class II restricted T cells. The *in vivo* administration of PADRE® peptide(s) stimulates the proliferation of HTL in normal humans as well as patient populations.

Please replace the paragraph beginning on page 70, line 30 with the following paragraph:

A vaccine in accordance with the invention comprises eight peptide epitopes bearing the HLA-A2 supermotif. Collectively, these eight epitopes are derived from the tumor associated antigens (TAAs) HER2/neu, p53, MAGE 2, MAGE3, and carcinoembryonic antigen (CEA), and stimulate CTL responses to these TAAs. (see Table 9) These eight peptides, which are also presented in Table 6, bear an HLA-A2 supermotif. Optionally, a ninth peptide, an HTL epitope that enhances CTL responses such as a pan-DR-binding peptide (PADRE®, Epimmune, San Diego, CA), is included.

Please replace the paragraph beginning on page 71, line 21 with the following paragraph:

An A2 vaccine comprises a cocktail of 12 peptides, 10 of which stimulate CTL responses to the tumor associated antigens (TAA) HER2/neu, p53, MAGE 2/3, and carcinoembryonic antigen (CEA). The remaining two peptides are both members of the PADRE® family of peptides that are HTL epitopes that enhance CTL responses (see Table 10). This embodiment of an A2 Vaccine is used in combination with an emulsion-based adjuvant such as Montanide® ISA51 or ISA720 (Seppic, Paris, France) or an Incomplete Freund's Adjuvant, preferably administered by injection. As appreciated by those of skill in the art, alternative modes of administration can also be used. Many adjuvants are known in the art, and are used in accordance with the present invention, see, *e.g.*, Tomlinson, *et al.*, Advanced Drug Delivery Reviews, Vol. 32(3) (6 July 1998).

Please replace the paragraph beginning on page 72, line 4 with the following paragraph:

Two peptides that stimulate HLA class II are also used in accordance with the invention. For instance, a pan-DR-binding epitope peptide having the formula: aKXVAAZTLKAAa, where "X" is either cyclohexylalanine, phenylalanine, or tyrosine; "Z" is either tryptophan, tyrosine, histidine or asparagine; and "a" is either D-alanine or L-alanine (SEQ ID NO:29), has been found to bind to most HLA-DR alleles, and to stimulate the response of T helper lymphocytes from most individuals, regardless of their HLA type. Two particularly preferred PADRE® molecules are the peptides, aKFVAAYTLKAAa-NH_2 and aKXVAAHTLKAAa-NH_2 (a = D-alanine, X = cyclohexylalanine), the latter containing a non-natural amino acid, specifically engineered to maximize both HLA-DR binding capacity and induction of T cell immune responses.

Please replace the paragraph beginning on page 72, line 14 with the following paragraph:

The PADRE® peptide components of the A2 vaccine bind with high affinity and broad specificity to multiple allelic forms of HLA-DR molecules ($IC_{50} \leq 1000$ nM). The *in vivo* administration of PADRE® peptide stimulates the proliferation of HTL in normal humans as well as patient populations. Thus, this vaccine embodiment is effective in stimulating the cellular arm of the immune system to mediate immune responses against tumors.